APPENDIX—WATER-QUALITY DATA FROM THE SANTEE RIVER BASIN AND COASTAL DRAINAGES IN A NATIONAL CONTEXT

For a complete view of Santee River Basin and coastal drainages data and for additional information about specific benchmarks used, visit our Web site at http://water.usgs.gov/nawqa/. Also visit the NAWQA Data Warehouse for access to NAWQA data sets at http://infotrek.er.usgs.gov/wdbctx/nawqa/nawqa.home.

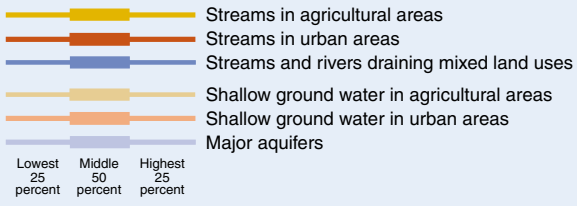
This appendix is a summary of chemical concentrations and biological indicators assessed in the Santee River Basin and coastal drainages. Selected results for this Study Unit are graphically compared to results from as many as 36 NAWQA Study Units investigated from 1991 to 1998 and to national water-quality benchmarks for human health, aquatic life, or fish-eating wildlife. The chemical and biological indicators shown were selected on the basis of frequent detection, detection at concentrations above a national benchmark, or regulatory or scientific importance. The graphs illustrate how conditions associated with each land use sampled in the Santee River Basin and coastal drainages compare to results from across the Nation, and how conditions compare among the several land uses. Graphs for chemicals show only detected concentrations and, thus, care must be taken to evaluate detection frequencies in addition to concentrations when comparing study-unit and national results. For example, tebuthiuron concentrations in Santee River Basin and coastal drainages agricultural streams were similar to the national distribution, but the detection frequency was much higher (66 percent compared to 22 percent).

CHEMICALS IN WATER

Concentrations and detection frequencies, Santee River Basin and coastal drainages, 1995–98—Detection sensitivity varies among chemicals and, thus, frequencies are not directly comparable

- ◆ Detected concentration in Study Unit
- 66 38 Frequencies of detection, in percent. Detection frequencies were not censored at any common reporting limit. The left-hand column is the study-unit frequency and the right-hand column is the national frequency
- -- Not measured or sample size less than two
- 12 Study-unit sample size. For ground water, the number of samples is equal to the number of wells sampled

National ranges of detected concentrations, by land use, in 36 NAWQA Study Units, 1991–98—Ranges include only samples in which a chemical was detected

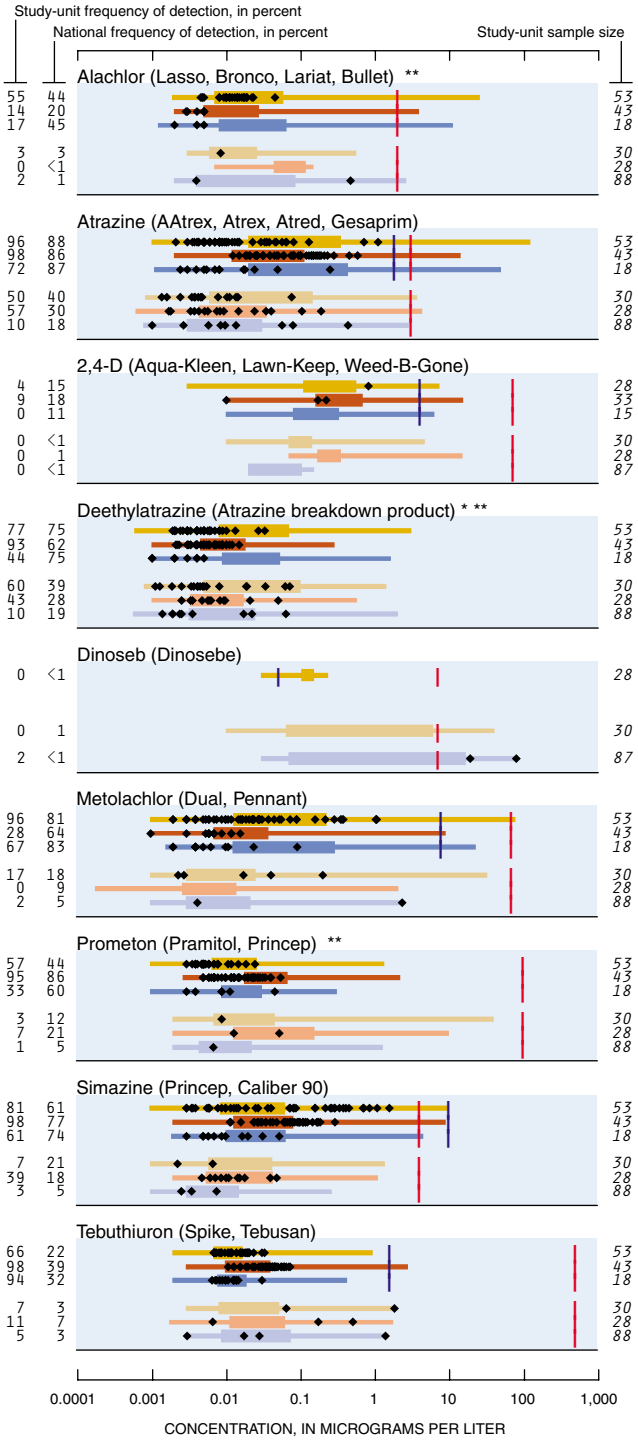


National water-quality benchmarks

National benchmarks include standards and guidelines related to drinking-water quality, criteria for protecting the health of aquatic life, and a goal for preventing stream eutrophication due to phosphorus. Sources include the U.S. Environmental Protection Agency and the Canadian Council of Ministers of the Environment

- | Drinking-water quality (applies to ground water and surface water)
- | Protection of aquatic life (applies to surface water only)
- | Prevention of eutrophication in streams not flowing directly into lakes or impoundments
- * No benchmark for drinking-water quality
- ** No benchmark for protection of aquatic life

Pesticides in water—Herbicides



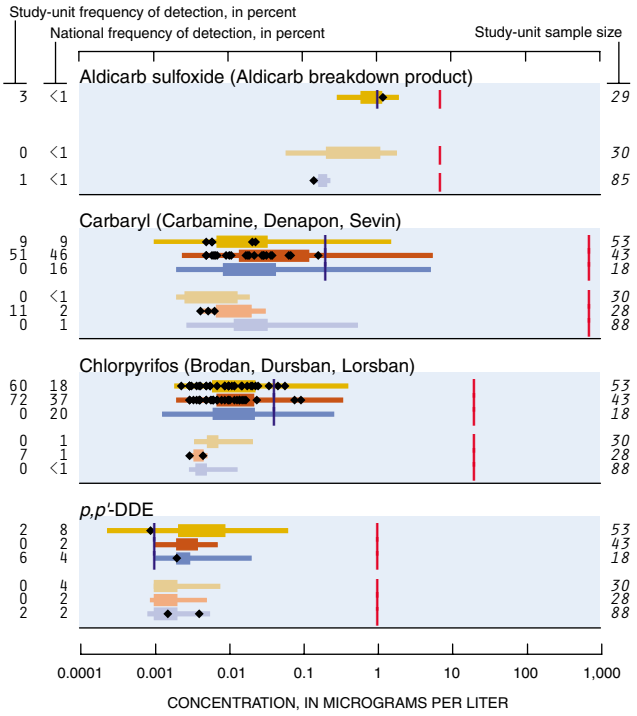
Other herbicides detected

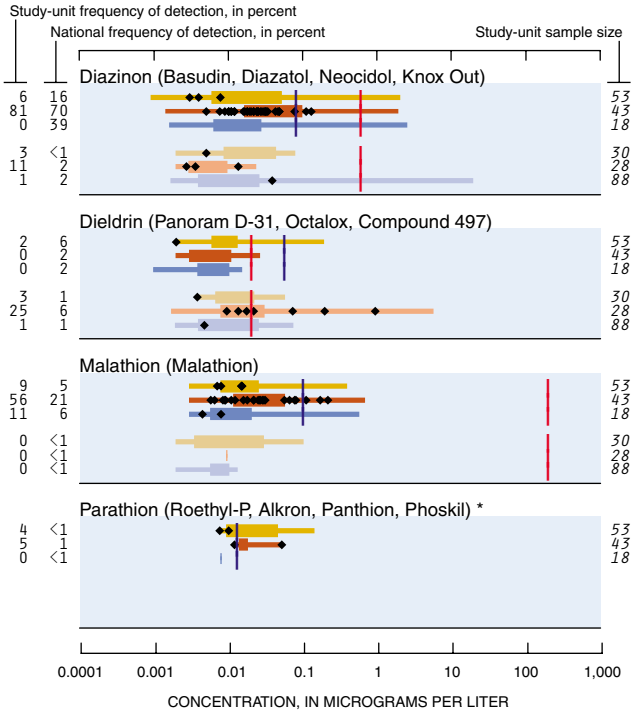
Acifluorfen (Blazer, Tackle 2S) **
Benfluralin (Balan, Benefin, Bonalan) * **
Bentazon (Basagran, Bentazone) **
Bromacil (Hyvar X, Urox B, Bromax)
Butylate (Sutan +, Genate Plus, Butilate) **

Cyanazine (Bladex, Fortrol)
DCPA (Dacthal, chlorthal-dimethyl) * **
2,6-Diethylaniline (Alachlor breakdown product) * **
Diuron (Crisuron, Karmex, Diurex) **
EPTC (Eptam, Farmarox, Alirox) * **
Ethalfluralin (Sonalan, Curbit) * **
Fenuron (Fenulon, Fenidim) * **
Fluometuron (Flo-Met, Cotoran) **
Linuron (Lorox, Linex, Sarclex, Linurex, Afalon) *
Metribuzin (Lexone, Sencor)
Molinate (Ordram) * **
Neburon (Neburea, Neburyl, Noruben) * **
Norflurazon (Evital, Predict, Solicam, Zorial) * **
Oryzalin (Surflan, Dirimal) * **
Pendimethalin (Pre-M, Prowl, Stomp) * **
Pronamide (Kerb, Propyzamid) **
Propham (Tuberite) **
Terbacil (Sinbar) **
Trifluralin (Treflan, Gowan, Tri-4, Trific)

Herbicides not detected
Acetochlor (Harness Plus, Surpass) * **
Bromoxynil (Buctril, Brominal) *
Chloramben (Amiben, Amilon-WP, Vegiben) **
Clopyralid (Stinger, Lontrel, Transline) * **
2,4-DB (Butyrac, Butoxone, Embutox Plus, Embutone) * **
Dacthal mono-acid (Dacthal breakdown product) * **
Dicamba (Banvel, Dianat, Scotts Proturf)
Dichlorprop (2,4-DP, Seritox 50, Lentemul) * **
MCPA (Rhomene, Rhonox, Chiptox)
MCPB (Thistrol) * **
Napropamide (Devrinol) * **
Pebulate (Tillam, PEBC) * **
Picloram (Grazon, Tordon)
Propachlor (Ramrod, Satecid) **
Propanil (Stam, Stampede, Wham) * **
2,4,5-T **
2,4,5-TP (Silvex, Fenoprop) **
Thiobencarb (Bolero, Saturn, Benthiocarb) * **
Triallate (Far-Go, Avadex BW, Tri-allate) *
Triclopyr (Garlon, Grandstand, Redeem, Remedy) * **

Pesticides in water—Insecticides



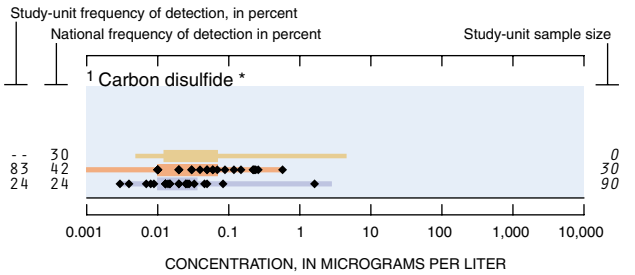


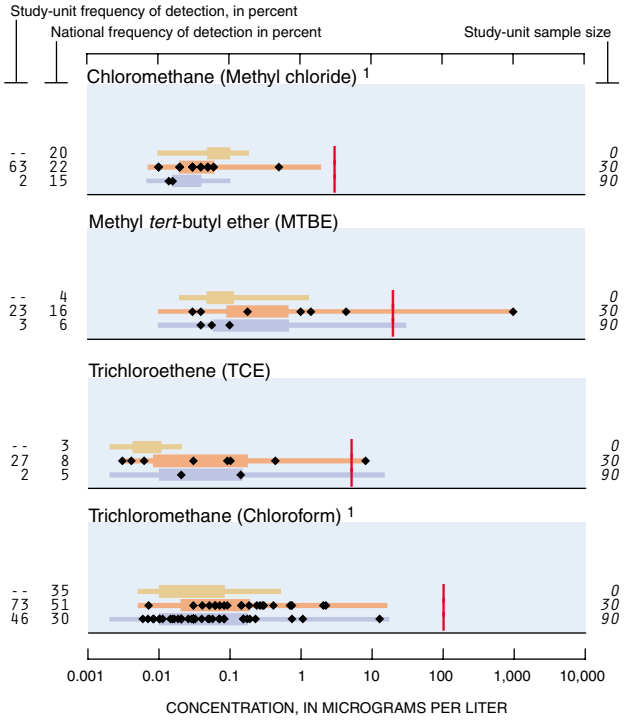
Other insecticides detected
Aldicarb (Temik, Ambush, Pounce)
Aldicarb sulfone (Standak, aldoxycarb)
Carbofuran (Furadan, Curaterr, Yaltox)
Fonofos (Dyfonate, Capfos, Cudgel, Tycap) **
3-Hydroxycarbofuran (Carbofuran breakdown product) * **
Methiocarb (Slug-Geta, Grandslam, Mesurol) * **
Methomyl (Lanox, Lannate, Acinate) **
Oxamyl (Vydate L, Pratt) **
cis-Permethrin (Ambush, Astro, Pounce) * **
Propoxur (Baygon, Blattanex, Unden, Proprotox) * **

Insecticides not detected
Azinphos-methyl (Guthion, Gusathion M) *
Disulfoton (Disyston, Di-Syston) **
Ethoprop (Mocap, Ethoprophos) * **
alpha-HCH (alpha-BHC, alpha-lindane) **
gamma-HCH (Lindane, gamma-BHC)
Methyl parathion (Penncap-M, Folidol-M) **
Phorate (Thimet, Granutox, Geomet, Rampart) * **
Propargite (Comite, Omite, Ornamite) * **
Terbufos (Contraven, Counter, Pilarfox) **

Volatile organic compounds (VOCs) in ground water

These graphs represent data from 16 Study Units, sampled from 1996 to 1998





[1] Many of the samples in this study were diluted prior to laboratory analysis and therefore the actual detection frequency may be larger than the value listed.

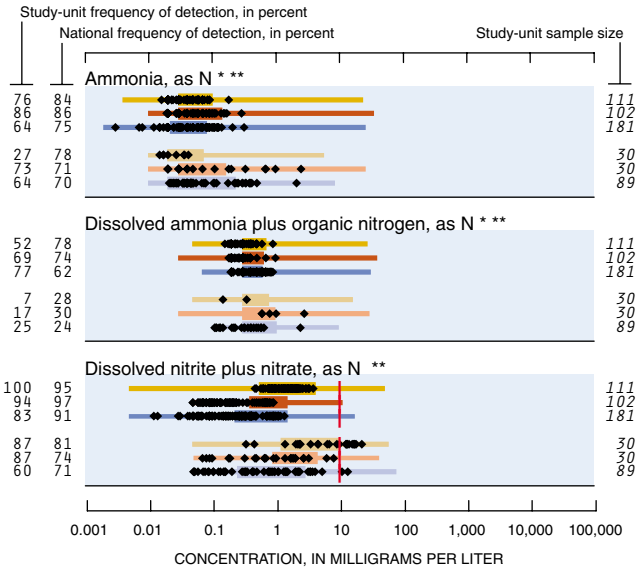
Other VOCs detected

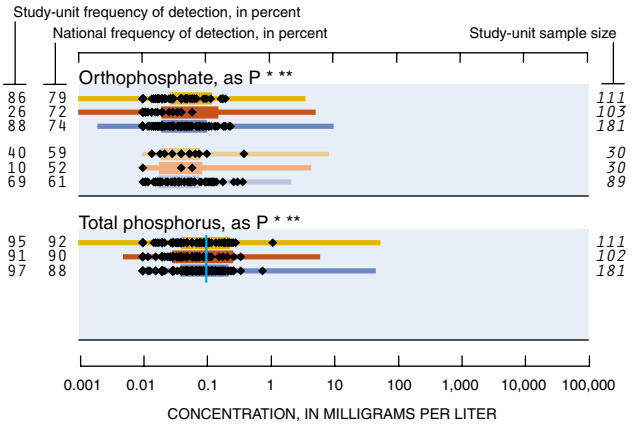
tert-Amylmethylether (*tert*-amyl methyl ether (TAME)) *
Benzene
Bromodichloromethane (Dichlorobromomethane)
Bromomethane (Methyl bromide)
2-Butanone (Methyl ethyl ketone (MEK)) *
sec-Butylbenzene *
tert-Butylbenzene *
Chlorobenzene (Monochlorobenzene)
Chlorodibromomethane (Dibromochloromethane)
Chloroethane (Ethyl chloride) *
Chloroethene (Vinyl chloride)
1,2-Dichlorobenzene (*o*-Dichlorobenzene)
1,3-Dichlorobenzene (*m*-Dichlorobenzene)
1,4-Dichlorobenzene (*p*-Dichlorobenzene)
Dichlorodifluoromethane (CFC 12, Freon 12)
1,2-Dichloroethane (Ethylene dichloride)
1,1-Dichloroethane (Ethylidene dichloride) *
1,1-Dichloroethene (Vinylidene chloride)
trans-1,2-Dichloroethene ((E)-1,2-Dichlorothene)
cis-1,2-Dichloroethene ((Z)-1,2-Dichloroethene)
Dichloromethane (Methylene chloride)
1,2-Dichloropropane (Propylene dichloride)
Diethyl ether (Ethyl ether) *
1,2-Dimethylbenzene (*o*-Xylene)
1,3 & 1,4-Dimethylbenzene (*m*-&*p*-Xylene)
1-4-Epoxy butane (Tetrahydrofuran, Diethylene oxide) *
Ethylbenzene (Phenylethane)
Iodomethane (Methyl iodide) *
Isopropylbenzene (Cumene) *
p-Isopropyltoluene (*p*-Cymene) *
Methylbenzene (Toluene)
2-Propanone (Acetone) *
1,1,2,2-Tetrachloroethane *
Tetrachloroethene (Perchloroethene)
Tetrachloromethane (Carbon tetrachloride)
1,2,3,5-Tetramethylbenzene (Isodurene) *
Tribromomethane (Bromoform)
1,1,1-Trichloroethane (Methylchloroform)
Trichlorofluoromethane (CFC 11, Freon 11)

VOCs not detected

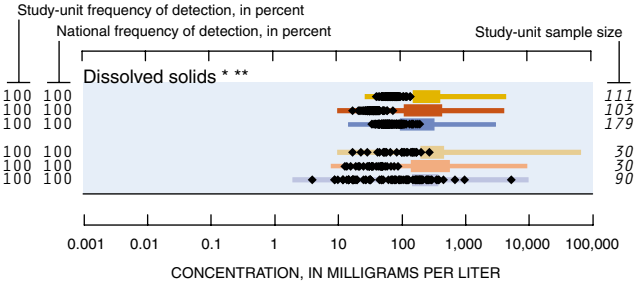
Bromobenzene (Phenyl bromide) *
Bromochloromethane (Methylene chlorobromide)
Bromoethene (Vinyl bromide) *
n-Butylbenzene (1-Phenylbutane) *
3-Chloro-1-propene (3-Chloropropene) *
1-Chloro-2-methylbenzene (*o*-Chlorotoluene)
1-Chloro-4-methylbenzene (*p*-Chlorotoluene)
1,2-Dibromo-3-chloropropane (DBCP, Nemagon)
1,2-Dibromoethane (Ethylene dibromide, EDB)
Dibromomethane (Methylene dibromide) *
trans-1,4-Dichloro-2-butene ((Z)-1,4-Dichloro-2-butene) *
2,2-Dichloropropane *
1,3-Dichloropropane (Trimethylene dichloride) *
trans-1,3-Dichloropropene ((E)-1,3-Dichloropropene)
cis-1,3-Dichloropropene ((Z)-1,3-Dichloropropene)
1,1-Dichloropropene *
Diisopropyl ether (Diisopropylether (DIPE)) *
Ethenylbenzene (Styrene)
Ethyl methacrylate *
Ethyl *tert*-butyl ether (Ethyl-*t*-butyl ether (ETBE)) *
1-Ethyl-2-methylbenzene (2-Ethyltoluene) *
Hexachlorobutadiene
1,1,1,2,2,2-Hexachloroethane (Hexachloroethane)
2-Hexanone (Methyl butyl ketone (MBK)) *
Methyl acrylonitrile *
Methyl-2-methacrylate (Methyl methacrylate) *
4-Methyl-2-pentanone (Methyl isobutyl ketone (MIBK)) *
Methyl-2-propenoate (Methyl acrylate) *
Naphthalene
2-Propenenitrile (Acrylonitrile)
n-Propylbenzene (Isocumene) *
1,1,1,2-Tetrachloroethane
1,2,3,4-Tetramethylbenzene (Prehnitene) *
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113) *
1,2,4-Trichlorobenzene
1,2,3-Trichlorobenzene *
1,1,2-Trichloroethane (Vinyl trichloride)
1,2,3-Trichloropropane (Allyl trichloride)
1,2,3-Trimethylbenzene (Hemimellitene) *
1,2,4-Trimethylbenzene (Pseudocumene) *
1,3,5-Trimethylbenzene (Mesitylene) *

Nutrients in water

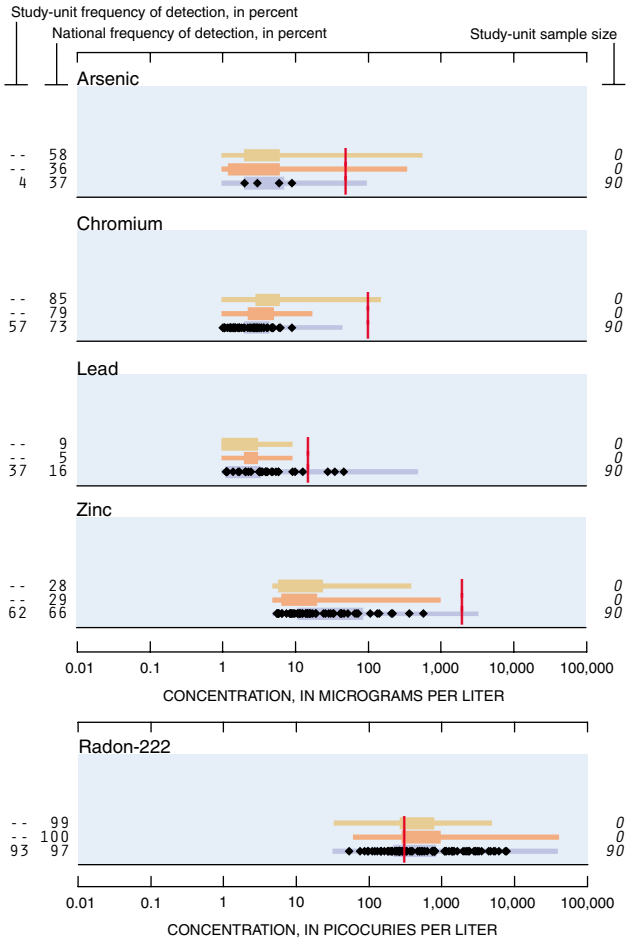




Dissolved solids in water



Trace elements in ground water



Other trace elements detected
Selenium
Uranium

Trace elements not detected
Cadmium

CHEMICALS IN FISH TISSUE AND BED SEDIMENT

Concentrations and detection frequencies, Santee River Basin and coastal drainages, 1995–98—Detection sensitivity varies among chemicals and, thus, frequencies are not directly comparable among chemicals. Study-unit frequencies of detection are based on small sample sizes; the applicable sample size is specified in each graph

◆ Detected concentration in Study Unit

66 38 Frequencies of detection, in percent. Detection frequencies were not censored at any common reporting limit. The left-hand column is the study-unit frequency and the right-hand column is the national frequency

-- Not measured or sample size less than two

12 Study-unit sample size

National ranges of concentrations detected, by land use, in 36 NAWQA Study Units, 1991–98—Ranges include only samples in which a chemical was detected

Fish tissue from streams in agricultural areas
Fish tissue from streams in urban areas
Fish tissue from streams draining mixed land uses
Sediment from streams in agricultural areas
Sediment from streams in urban areas
Sediment from streams draining mixed land uses

Lowest 25 percent | Middle 50 percent | Highest 25 percent

National benchmarks for fish tissue and bed sediment

National benchmarks include standards and guidelines related to criteria for protection of the health of fish-eating wildlife and aquatic organisms. Sources include the U.S. Environmental Protection Agency, other Federal and State agencies, and the Canadian Council of Ministers of the Environment

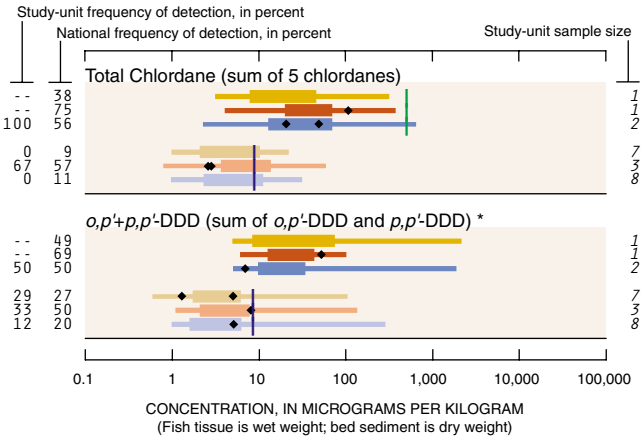
| Protection of fish-eating wildlife (applies to fish tissue)

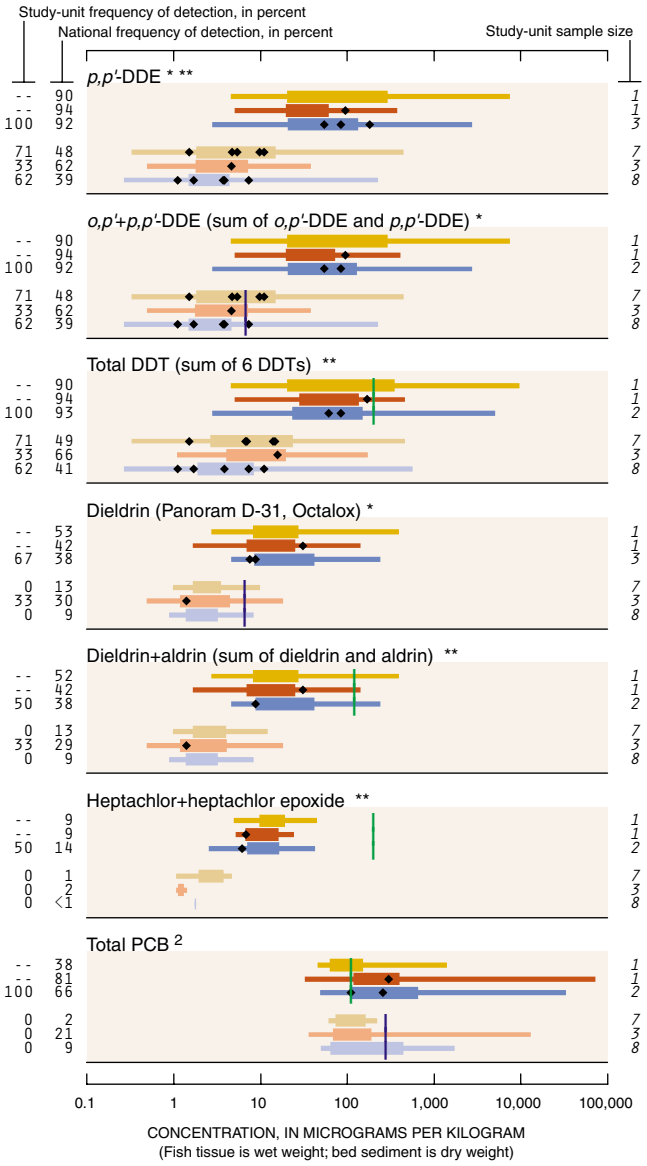
| Protection of aquatic life (applies to bed sediment)

* No benchmark for protection of fish-eating wildlife

** No benchmark for protection of aquatic life

Organochlorines in fish tissue (whole body) and bed sediment





2 The national detection frequencies for total PCB in sediment are biased low because about 30 percent of samples nationally had elevated detection levels compared to this Study Unit. See http://water.usgs.gov/nawqa/ for additional information.

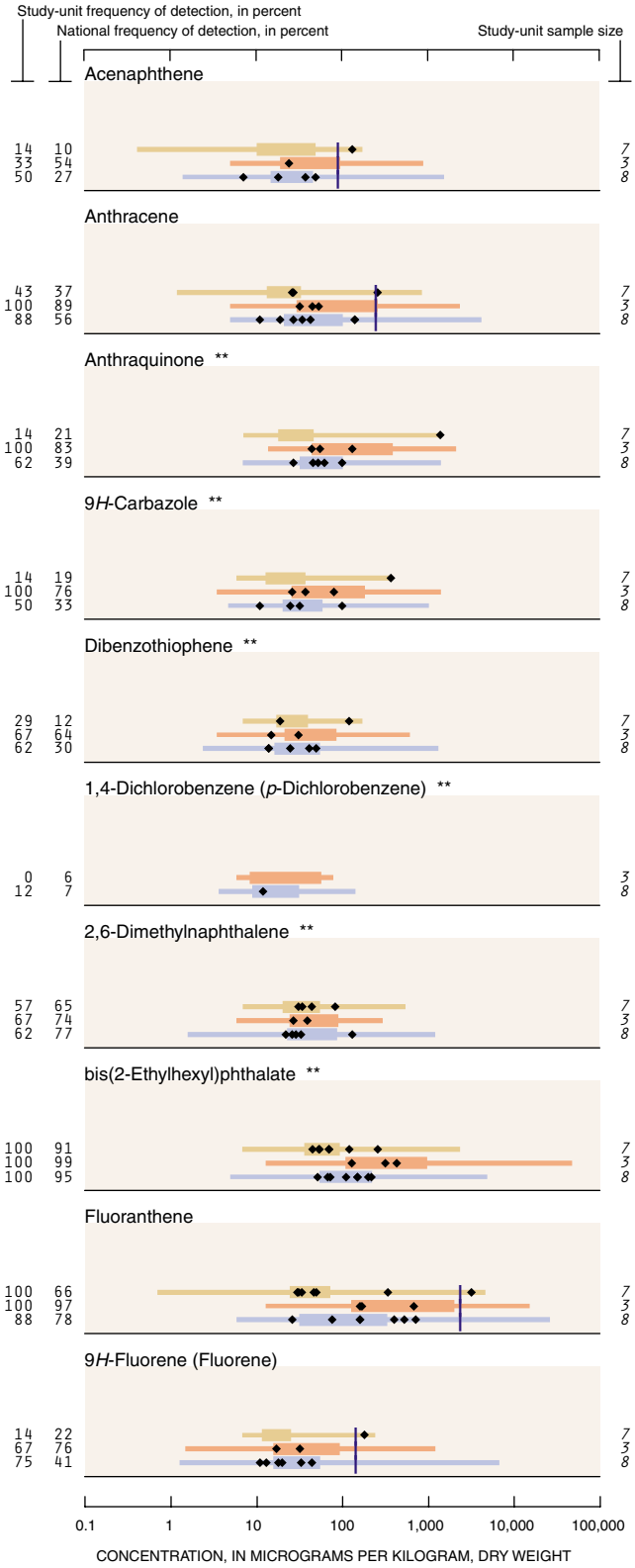
Other organochlorines detected

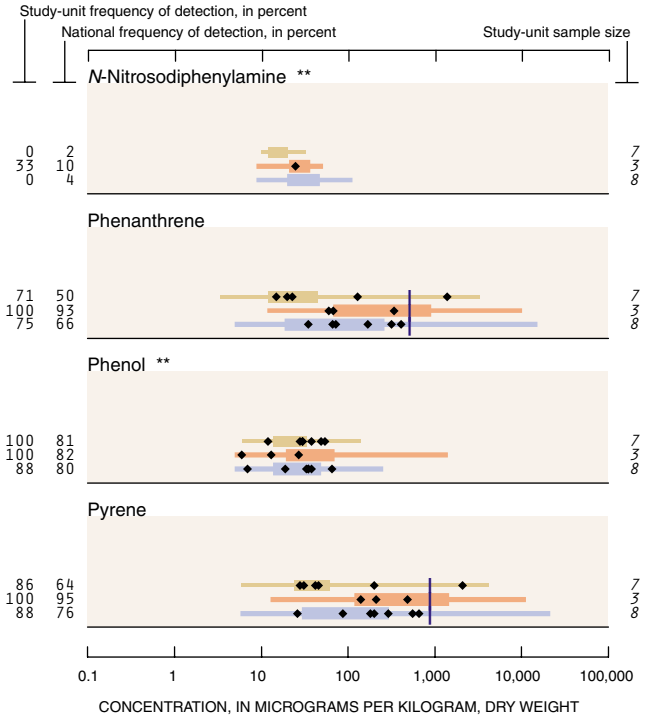
DCPA (Dacthal, chlorthal-dimethyl) * **
o,p'+*p,p'*-DDT (sum of *o,p'*-DDT and *p,p'*-DDT) *
Heptachlor epoxide (Heptachlor breakdown product) *
Hexachlorobenzene (HCB) **
Mirex (Dechlorane) **

Organochlorines not detected

Chloroneb (Chloronebe, Demosan) * **
Endosulfan I (alpha-Endosulfan, Thiodan) * **
Endrin (Endrine)
gamma-HCH (Lindane, gamma-BHC, Gammexane) *
Total-HCH (sum of alpha-HCH, beta-HCH, gamma-HCH, and delta-HCH) **
Isodrin (Isodrine, Compound 711) * **
p,p'-Methoxychlor (Marlate, methoxychlore) * **
o,p'-Methoxychlor * **
cis-Permethrin (Ambush, Astro, Pounce) * **
trans-Permethrin (Ambush, Astro, Pounce) * **
Toxaphene (Camphechlor, Hercules 3956) * **

Semivolatile organic compounds (SVOCs) in bed sediment





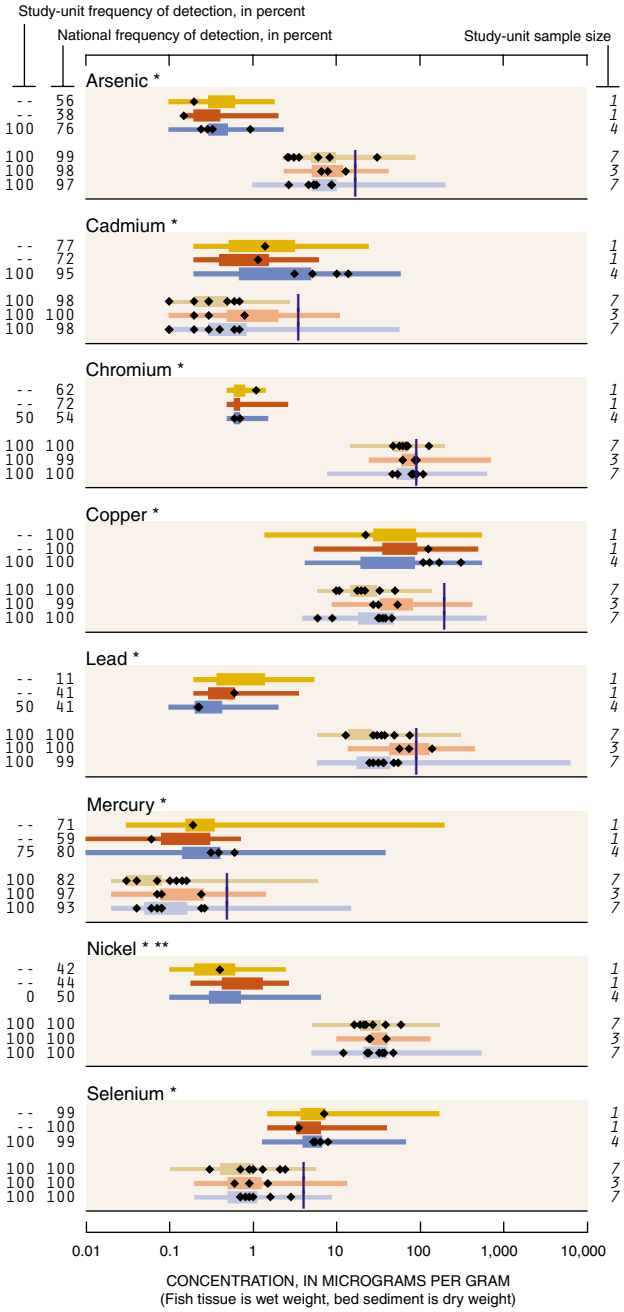
Other SVOCs detected

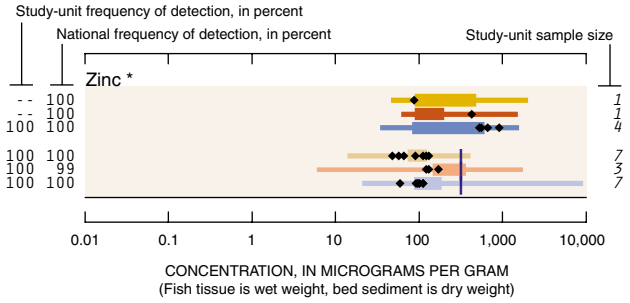
Acenaphthylene
Acridine **
Benz[*a*]anthracene
Benzo[*a*]pyrene
Benzo[*b*]fluoranthene **
Benzo[*ghi*]perylene **
Benzo[*k*]fluoranthene **
Butylbenzylphthalate **
Chrysene
p-Cresol **
Di-*n*-butylphthalate **
Di-*n*-octylphthalate **
Dibenz[*a,h*]anthracene
Diethylphthalate **
1,2-Dimethylnaphthalene **
1,6-Dimethylnaphthalene **
Dimethylphthalate **
2-Ethylnaphthalene **
Indeno[1,2,3-*cd*]pyrene **
Isoquinoline **
1-Methyl-9*H*-fluorene **
2-Methylanthracene **
4,5-Methylenephenanthrene **
1-Methylphenanthrene **
1-Methylpyrene **
Naphthalene
Phenanthridine **
Quinoline **
2,3,6-Trimethylnaphthalene **

SVOCs not detected

C8-Alkylphenol **
Azobenzene **
Benzo[*c*]cinnoline **
2,2-Biquinoline **
4-Bromophenyl-phenylether **
4-Chloro-3-methylphenol **
bis(2-Chloroethoxy)methane **
2-Chloronaphthalene **
2-Chlorophenol **
4-Chlorophenyl-phenylether **
1,2-Dichlorobenzene (*o*-Dichlorobenzene) **
1,3-Dichlorobenzene (*m*-Dichlorobenzene) **
3,5-Dimethylphenol **
2,4-Dinitrotoluene **
Isophorone **
Nitrobenzene **
N-Nitrosodi-*n*-propylamine **
Pentachloronitrobenzene **
1,2,4-Trichlorobenzene **

Trace elements in fish tissue (livers) and bed sediment





BIOLOGICAL INDICATORS

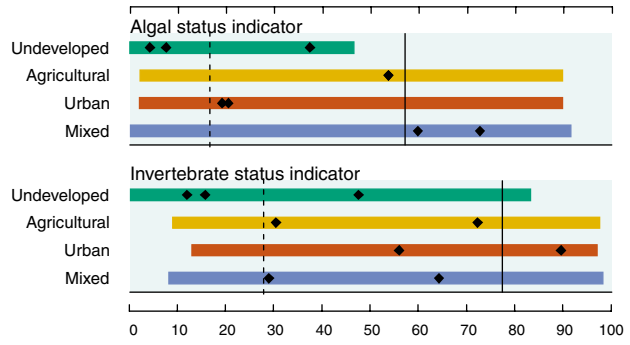
Higher national scores suggest habitat disturbance, water-quality degradation, or naturally harsh conditions. The status of algae, invertebrates (insects, worms, and clams), and fish provide a record of water-quality and stream conditions that water-chemistry indicators may not reveal. **Algal status** focuses on the changes in the percentage of certain algae in response to increasing siltation, and it often correlates with higher nutrient concentrations in some regions. **Invertebrate status** averages 11 metrics that summarize changes in richness, tolerance, trophic conditions, and dominance associated with water-quality degradation. **Fish status** sums the scores of four fish metrics (percent tolerant, omnivorous, non-native individuals, and percent individuals with external anomalies) that increase in association with water-quality degradation

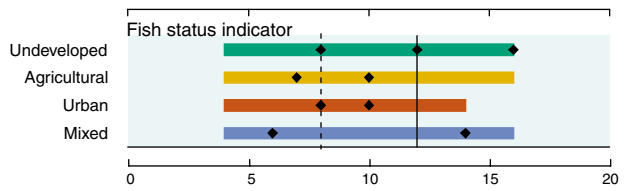
Biological indicator value, Santee River Basin and coastal drainages, by land use, 1995–98

◆ Biological status assessed at a site

National ranges of biological indicators, in 16 NAWQA Study Units, 1994–98

- Streams in undeveloped areas
- Streams in agricultural areas
- Streams in urban areas
- Streams in mixed-land-use areas
- 75th percentile
- 25th percentile





A COORDINATED EFFORT

Coordination with agencies and organizations in the Santee River Basin and coastal drainages was integral to the success of this water-quality assessment. We thank those who served as members of our liaison committee.

Federal Agencies
National Park Service, Congaree Swamp National Monument
Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service
U.S. Forest Service

State Agencies
North Carolina Department of Environment and Natural Resources
Ocean and Coastal Resource Management
South Carolina Department of Health and Environmental Control
South Carolina Department of Natural Resources
South Carolina Forestry Commission
South Carolina Geological Survey
South Carolina Sea Grant Consortium
South Carolina Water Resources Research Institute

Local Agencies
Catawba Regional Planning Council
Charlotte-Mecklenburg Utility Department
Gaston County Cooperative Extension Service
Greenville County Soil and Water Conservation District
Western Piedmont Council of Governments

Universities
Columbia College
South Carolina State University
University of North Carolina at Charlotte
University of South Carolina

Other public and private organizations
Catawba Nation
Clean Water Fund of North Carolina
Duke Energy
National Audubon Society
South Carolina Electric and Gas Company
South Carolina Rural Water Association

We thank the following individuals for contributing to this effort.

Barbara Kleiss, Ted Campbell, and Sandra Cooper (USGS); Barry Beasley (South Carolina Department of Natural Resources); and Oscar Penegar (Environmental Advocate) for reviewing the report.

Jeannie Eidson (South Carolina Department of Environmental Control) for providing support and data for geographic information systems.

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Gary Taylor and Ralph Willoughby (South Carolina Geological Survey) for assisting in drilling wells.

The numerous property owners who allowed the USGS to install monitoring wells or sample existing wells on their property.

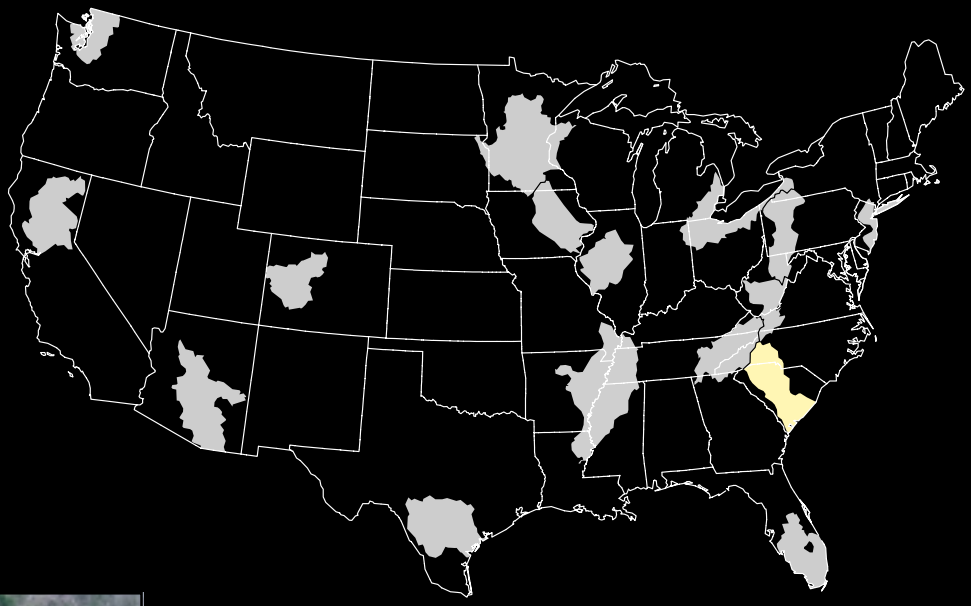
Ben Abercrombie, Boyce Blanks, Wade Bryant, Kristen Hein, Cliff Hupp, Robert Kelley, Donald Leary, Krystal Lynn, Brent Means, Larry Puckett, Whitney Stringfield, Robert Thorn, and Carlton Wood for providing invaluable technical and field support for the study.

Dick Christie (South Carolina Department of Natural Resources), Ginny Lindsey (North Carolina Clean Water Fund), and Charlie Zemp (South Carolina Department of Natural Resources) for providing guided tours of parts of the Santee Basin.

This report is dedicated to the memory of Don Leary; his quiet strength, hard work, and good humor helped make this study a success.

NAWQA

National Water-Quality Assessment (NAWQA) Program
Santee River Basin and Coastal Drainages



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Hughes and others— Water Quality in the Santee River Basin and Coastal Drainages
U.S. Geological Survey Circular 1206